

# **Approach for Assessing the Costs and Benefits of Using Remotely Sensed Data for Environmental Analysis in Transportation Planning (DRAFT)**

**Prepared for the project "Remote Sensing Applications for Environmental Analysis in Transportation Planning: Application to the Washington State I-405 Corridor"**

**Russell Lee, Demin Xiong, J. Bo Saulsbury  
Oak Ridge National Laboratory**

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## **1. Introduction**

This memorandum describes the planned approach to assess the costs and benefits of using remotely sensed data for environmental analysis in transportation planning, using the I-405 project as a case study. This study focuses on land use and land cover (LULC) classification and its application to providing information that would be useful for the transportation planning and environmental analysis process. This cost-benefit assessment will provide a sense of the value of the information and insight provided by remotely sensed data when used in combination with geographic information systems and other conventional spatial data technologies.

## **2. Scope**

LULC information is commonly compiled and analyzed for the purposes of satisfying requirements under the National Environmental Policy Act (NEPA), as well as for other legislative, regulatory and permitting requirements. The cost-benefit analysis will assess the incremental value of LULC-related information that is to be developed using remotely sensed data, relative to a baseline set of information representing current practice.

For this case study, we use information in the Environmental Impact Statement (EIS) for the I-405 Corridor Program (U.S. DOT et al. 2001) as the baseline representing the current state-of-the-art practice for environmental analysis in transportation planning. Additional LULC-related information -- the maps, images, and analytical information provided by remotely sensed data that are integrated with other spatial data -- will be compared to this baseline. We refer to these two sets of information as "current practice" and "RS/GIS," respectively.

As reflected in the EIS, LULC information is used in descriptions and analyses of the different environmental Disciplines that the NEPA process typically addresses (number in parenthesis is the section number in the EIS report):

- Water resources - surface water (3.5)
- Wetlands (3.6)
- Threatened and endangered species habitat (3.7)
- Fish and aquatic habitat (3.8)
- Farmland (3.9)
- Floodplains (3.10)
- Shorelines (3.11)
- Transportation (3.12)

- Land use (3.13)
- Displacement (3.14)
- Recreational resources (3.17)
- Utilities (3.19).

We plan to consider these categories and to compare the costs and benefits of developing and providing information about these Disciplines using RS/GIS methods, using a baseline as defined by current practice. The comparisons will focus on aspects in which RS/GIS methods could provide complementary or supplementary information.

### **3. Approach for Developing Estimates of Benefits and Costs**

The categories and ways of measuring information about each Discipline vary, as do the data sources, data manipulation required, and presentation format. These attributes in turn affect the nature and value of the information presented, as well as the costs of compiling it. We plan to present the results of the cost-benefit analysis in a format that facilitates comparisons and assessments of the incremental value of the RS/GIS approach for each of the Disciplines listed above. Specifically, we plan to develop three arrays of information:

- (1) Attributes,
- (2) Costs,
- (3) Benefits (including value relative to costs)

#### **(1) Attributes**

The results of the RS/GIS analysis to be completed in the other tasks of this research project will be compared briefly to the comparable information presented in the EIS, for selected Disciplines categories, in the format given in Form 1.

#### **(2) Costs**

Cost estimates are to be obtained from the agencies or contractors responsible for the different sections of the EIS that correspond to the different Disciplines to provide information on the costs of developing, compiling and presenting the information, data, and maps in the pertinent sections of the EIS.

The usefulness and cost-effectiveness of RS/GIS varies for different Disciplines. Thus, to gain insight into the particular Disciplines for which RS/GIS methods could be more cost-effective and useful, we plan to compile separate cost estimates for the work done on each Discipline. To minimize the burden on respondents, the information will be requested in a simple format as reflected in Form 2. Cost estimates could be obtained from either the contractors that performed the work, or the agencies to which they provided monthly or quarterly cost reports.

We think it reasonable to expect that cost data can be provided in this aggregate format. The cost categories are common, generic categories. Also, contractors are frequently required to report their costs by Discipline or task.

We plan to compile two different measures of the costs for the RS/GIS analysis. One measure will be an average cost per Discipline category, simply the total cost of the RS/GIS analysis divided by the number of Discipline categories. The second measure will be an estimate of the *marginal* cost of the analysis for the one additional Discipline category, given that work is done on all other categories.

Whenever work done and costs incurred pertain to more than one category, then the costs would be allocated to the Discipline for which the work was primarily done. One of the advantages of RS/GIS analysis is that LULC classifications can be done virtually simultaneously for several LULC categories, which is not the case when using conventional methods.<sup>1</sup>

### (3) Benefits

The benefits of the information and insight are to be assessed from the perspective of the *users* of the information, within the specific context of their needs. That is, users of this information will be asked to assess its value. This aspect of our approach is a particularly important feature of this study. The gauge of the value of the RS/GIS approach will not be based on remote-sensing experts' assessments of imagery, nor statistical estimates of the accuracy of classification algorithms, but rather on assessments by those who would be viewing and using the information. Specifically, we intend that staff of Federal, state, regional, local, and tribal organizations, EIS contractors, and other stakeholders will be asked to make these assessments using Form 3. Respondents would be given a copy of the relevant section of the EIS and a copy of the products of the RS/GIS analysis, and asked to briefly review the information and to complete the form.

Since RS/GIS is intended primarily as a supplement or complement, rather than as a substitute, for current practice, agency staff and stakeholders would be asked to assess the benefits of RS/GIS products in terms of their *incremental* contribution, as reflected in Question 1 of Form 3. Also, as discussed above under "Costs," respondents would be asked to assess separately the value of RS/GIS products for each Discipline.

Question 2 in Form 3 is very important. It provides information about the value of the RS/GIS products, how they are useful and how they could be improved. The cost estimate, for the work required to complete the section of the EIS that corresponds to the Discipline under consideration, provides a baseline piece of information for respondents.

## **4. Data Analysis**

The cost and benefits data will be analyzed. The cost data from Form 2 will be tabulated for individual Disciplines to the extent possible. Bar charts will be used to compare costs, and the breakdown in costs incurred (e.g., labor, software/hardware, etc.), for the relevant parts of the EIS. The additional costs of the RS/GIS analysis will be compiled and expressed as percentages relative to the baseline costs. Similar comparisons will be made for the time required to complete work under each of these two cases.

The data from Form 3 will be displayed in a matrix with the rows being the different Disciplines and the columns being the four possible assessments (for Question 1 of the Form 3). Each cell of the matrix will be the percentage of respondents who responded in the affirmative.

Analysis will then turn to the comments provided for Question 1 to identify patterns in the responses and situations in which RS/GIS products could be substitutes, improvements, or complements/supplements, and where they might detract from the environmental analysis.

If RS/GIS products are useful (i.e., responses 'a', 'b', or 'c'), then respondents' valuations of their benefits in monetary terms will be tabulated and analyzed. Responses will be analyzed for each of

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<sup>1</sup> Note that there are two other "economies" in using RS/GIS analysis, which our study will not assess: (a) geographic scale -- with RS/GIS analysis, the additional cost of studying a larger geographic area does *not* increase in proportion to the size of the area; and (b) transferability -- LULC classification algorithms identified in one study can be used elsewhere.

four possible responses at the top of the form; the respondents' descriptions of the material in the EIS which RS/GIS products might substitute for, replace, or complement; and their comments on how and why these products are useful.

Analysis of costs and benefits will be done for each Discipline to the extent possible. It might be more appropriate, however, to consider several categories as a group because the RS/GIS analysis could be done simultaneously on several Disciplines without a great increase in cost. This issue will be investigated.

Analysis will also assess whether any other patterns can be discerned, such as in the assessments by different types of respondents.

**5. Closing Comments**

The data to be compiled in the three forms will be from different sources as indicated in the following table.

Type of Data	Source
Description of data attributes	Study team
Costs	Contractor and/or agency staff
Benefits	Users of the Discipline-related data files and users of the environmental analysis information

Clearly, the results of one case study can not be used to draw definitive conclusions about the applications in which the benefits of RS/GIS methods could outweigh their costs. In fact, we do not anticipate having a sample of respondents in this study of sufficient size to have statistically significant results. Yet, it is hoped that the results will be sufficiently enlightening to help WSDOT and other environmental and transportation agencies in their planning for the development and use of some of these methods. We also anticipate that the results will be sufficiently interesting to encourage additional analysis of the benefits and costs of using remotely sensed data in these types of applications.

RS/GIS is not intended as a substitute for current practice. Rather we are aiming to identify areas in current practice where RS/GIS could cost-effectively complement or supplement (or possibly even replace) the information it provides, particularly in the presentation of geographic LULC information. The ultimate purpose of this use of remotely sensed data is to streamline and improve the environmental analysis and transportation planning process. Too much money and time are spent on redundant processes and analyses. It is hoped that RS/GIS products of the sort to be developed in this study can satisfy different needs for information on various environmental Disciplines, as required under various Federal laws, state statutes, local ordinances, and treaty obligations.

### Form 1. Description of Information from Conventional Practice and Using RS/GIS

Name of Discipline: \_\_\_\_\_

Attribute	Conventional Practice	Information from RS/GIS
Parameters or Categories		
Data Sources		
Data Manipulation Needed		
Presentation Format		

**Form 2. Costs of Developing and Presenting the Information in the EIS**  
**(All items in *thousands of dollars*, except the last item which is in months)**

Please complete the form, using a different form for the work done for each Discipline. The cost and time estimates are for all work done by all contractors, subcontractors, and agency staffs related to the specific Discipline.

Name of Discipline: \_\_\_\_\_

Cost Category	Cost ( \$'000) Or Months
1. Staff Labor Costs	
2. Other Costs (data, software and hardware acquisition; travel; materials and supplies)	
3. Indirect and Overhead Costs and Profit	
4. Total Cost for this Particular Discipline (Line 1 + Line 2 + Line 3)	
5. Amount of Time to Complete the Task (from the time the task was initiated to completion, in calendar-months)	

**Form 3. Assessing the Benefits of Products from RS/GIS Relative to Information from Conventional Practice, as Reflected in the Environmental Impact Statement (EIS)**

**INSTRUCTIONS:**

Information being compiled on this form will be used in a study being done by Washington State Department of Transportation (WSDOT) and Oak Ridge National Laboratory. The study is funded by WSDOT and the U.S. Department of Transportation. The purpose of the study is to assess the usefulness of information and maps that can be developed using remote sensing, for the purpose of environmental analysis in transportation planning. This study is using I-405 project in Washington as a case study. Environmental analysis for the I-405 project was recently completed and published in the Environmental Impact Statement (EIS).

We are asking you to assess the information and maps developed using a combination of remotely sensed data and geographic information systems (RS/GIS) in terms of their possible value in substituting for, replacing, or complementing and supplementing the work done for the EIS. (The EIS does not contain the RS/GIS material you are being asked to assess.)

Please review the sections from the EIS and the RS/GIS material, complete the attached form, and return to:

Russell Lee  
Oak Ridge National Laboratory  
P. O. Box 2008  
Oak Ridge, TN 37831-6205  
Or fax to: 865-574-5282 or -5283.

For questions about the analysis, please contact:

Demin Xiong  
Oak Ridge National Laboratory  
Phone: 865-574-2696  
E-mail: [xiongd@ornl.gov](mailto:xiongd@ornl.gov)

Or

Russell Lee  
Oak Ridge National Laboratory  
Phone: 865-576-6818  
E-mail: [leerm@ornl.gov](mailto:leerm@ornl.gov)

For further questions or information about the overall study, please contact:

Elizabeth Lanzer  
Washington Department of Transportation  
Environmental Affairs Office  
Phone: 360-705-7476  
E-mail: [lanzere@wsdot.wa.gov](mailto:lanzere@wsdot.wa.gov)

Thank you.

**Form 3. Assessing the Benefits of Products from Remote Sensing/Geographic Information Systems (RS/GIS) Relative to Information from Conventional Practice, as Reflected in the Environmental Impact Statement (EIS)**

Name of EIS Discipline: \_\_\_\_\_

1. Please circle the letter(s) of the statement(s) that reflects your assessment:

Compared to the EIS, the RS/GIS products would ...

- a. Be a comparable substitute for some of the information or data used, or work done for the EIS
- b. Improve the EIS by replacing some of the information used or work done for it
- c. Complement or supplement the EIS by providing additional useful information
- d. Detract from the EIS.

If your answer includes 'a' or 'b', please indicate which parts of the EIS (describe or give page numbers).

\_\_\_\_\_

2. If your answer includes 'a', 'b', or 'c', please answer the following question and provide comments:

(i) The cost of the work to complete the work on this Discipline, as reflected in Section x.x of the EIS, was about \$yyyy. What would it have been worth (either in addition to or instead of some of this expense) to have the RS/GIS products used for the EIS or as supplementary material? Please express your answer as a dollar amount or as a percentage relative to the total cost of completing the analysis for the Discipline.

\$ \_\_\_\_\_ or \_\_\_\_\_%

(ii) *How* or *why* are the RS/GIS products useful (use additional sheets if necessary)?

\_\_\_\_\_

\_\_\_\_\_

(iii) How could they be improved (use additional sheets if necessary)?

\_\_\_\_\_

\_\_\_\_\_

3. If your answer includes 'd', please comment on how the RS/GIS products would detract from the EIS (use additional sheets if necessary).

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